

C-CORE

Data Report

**Data Report Of The Hekja Wellsite
Marine Survey Undertaken During
CSS Hudson Cruise No. HU81-045
October, 1981**

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May, 1982

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The Centre for Cold Ocean Resources Engineering (C-CORE) was established at Memorial University of Newfoundland in St. John's in 1975. Its initial funding was provided by the Devonian Group of Charitable Foundations of Calgary. Ongoing funding now comes from government and industry.

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ABSTRACT

This report concerns the acquisition and some initial interpretation of raw data during a marine survey in the vicinity of the Hekja wellsite off Loks Land, southeast Baffin Island on the CSS Hudson. The program was undertaken on behalf of Canterra Energy Ltd. (formerly the Aquitaine Company of Canada Ltd.), as operator for the Baffin-Labrador Group of companies. Raw data collected included bottom sediment grabs, gravity and piston core samples, camera transects, shallow and deep tow sidescan transects, bathymetry, HUNTEC DTS high resolution seismic reflection transects, air-gun seismics and an iceberg log. Also presented are some preliminary observations made while the data was being collected.

ACKNOWLEDGEMENTS

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TABLE OF CONTENTS

	Page
ABSTRACT -----	i
ACKNOWLEDGEMENTS -----	ii
TABLE OF CONTENTS -----	iii
LIST OF FIGURES -----	v
LIST OF TABLES -----	v
1. INTRODUCTION AND SURVEY OBJECTIVES -----	1
2. SAMPLING PROGRAM -----	4
2.1 Sampling Rationale and Methods -----	4
3. Weather Conditions During Sampling Program -----	6
4. SUMMARY OF RAW DATA COLLECTED -----	10
4.1 Sidescan Survey -----	10
4.2 Bathymetry -----	10
4.3 Air gun Seismics -----	10
4.4 HUNTEC Deep Tow System Profiler -----	11
4.5 Sample Stations -----	11
4.6 Iceberg Log -----	11
4.7 Navigation -----	11
5.0 SUMMARY OF FIELD RESULTS -----	13
5.1 Bottom Sampling -----	13
5.2 Sidescan Surveys -----	15
REFERENCES -----	20
APPENDIX A C-CORE Personnel on Cruise -----	22
APPENDIX B Brief description of corers used -----	23

APPENDIX C Corrected copy of critique submitted to Canterra Energy Ltd. (formerly Aquitaine Company of Canada) prior to commencement of cruise -----	26
APPENDIX D Sample Positions and Descriptions -----	33

LIST OF FIGURES

	Page
Figure 1 - Study area -----	3
Figure 2 - Bathymetry of study area and sample stations--	8
Figure 3 - Computer printout of ships' track -----	9

LIST OF TABLES

	Page
Table 1: Iceberg log for the Hekja vicinity -----	18, 19

1. INTRODUCTION AND SURVEY OBJECTIVES

During the years 1980 and 1981, Geonautics Ltd. completed a sidescan and bathymetric survey off Loks Land (Figure 1) around the Hekja wellsite vicinity for Canterra Energy Ltd. (Geonautics, 1980a; b; 1981). Results of this survey unequivocally indicated that the seabed is extensively covered with iceberg scour marks, down to a depth of about 350 m and deeper. Scour features have rarely been recorded at these deep depths, although some evidence for their existence has been reported in the literature (Harris 1974; Harris and Jollymore, 1974). This find off Loks Land poses some interesting questions regarding the temporal nature of these scours, of which the following two are perhaps the most important:

- 1) are these scours a modern or a relict phenomena and
- 2) assuming the scours are indeed relict, then were they gouged out by icebergs with very deep draughts during the 'historical past' (i.e. the past few hundred years with the sea level being essentially the same as it is today) or were they perhaps gouged out in the distant past when the sea level was lower (vide Andrews, 1980)?

To effectively answer these questions we require information on both the age of the scours and the variations in sea level as a function of time since deglaciation, especially in the survey area.

In an effort to arrive at some answers, this project was designed, the objectives of which are:

- a) to re-examine the earlier surveyed site to see if any

scouring, or any other change had occurred in the interim;

- b) to date the scours relative to each other;
- c) to attempt to date the scours using radio isotopic dating techniques;
- d) to collect samples of the surficial sediments in order to determine the genesis and mobility of the surficial cover and its compaction and thickness;
- e) to obtain cores from the area and examine them radiographically and geotechnically, and
- f) to analyze the microfauna and the sediments in the cores to establish a temporal chronology for the cores.

The results will be collated and from them an attempt will be made to define a sea level curve for the survey area; the same data will be used to determine, (by inference) the probable age(s) of the scoured features on the seabed.

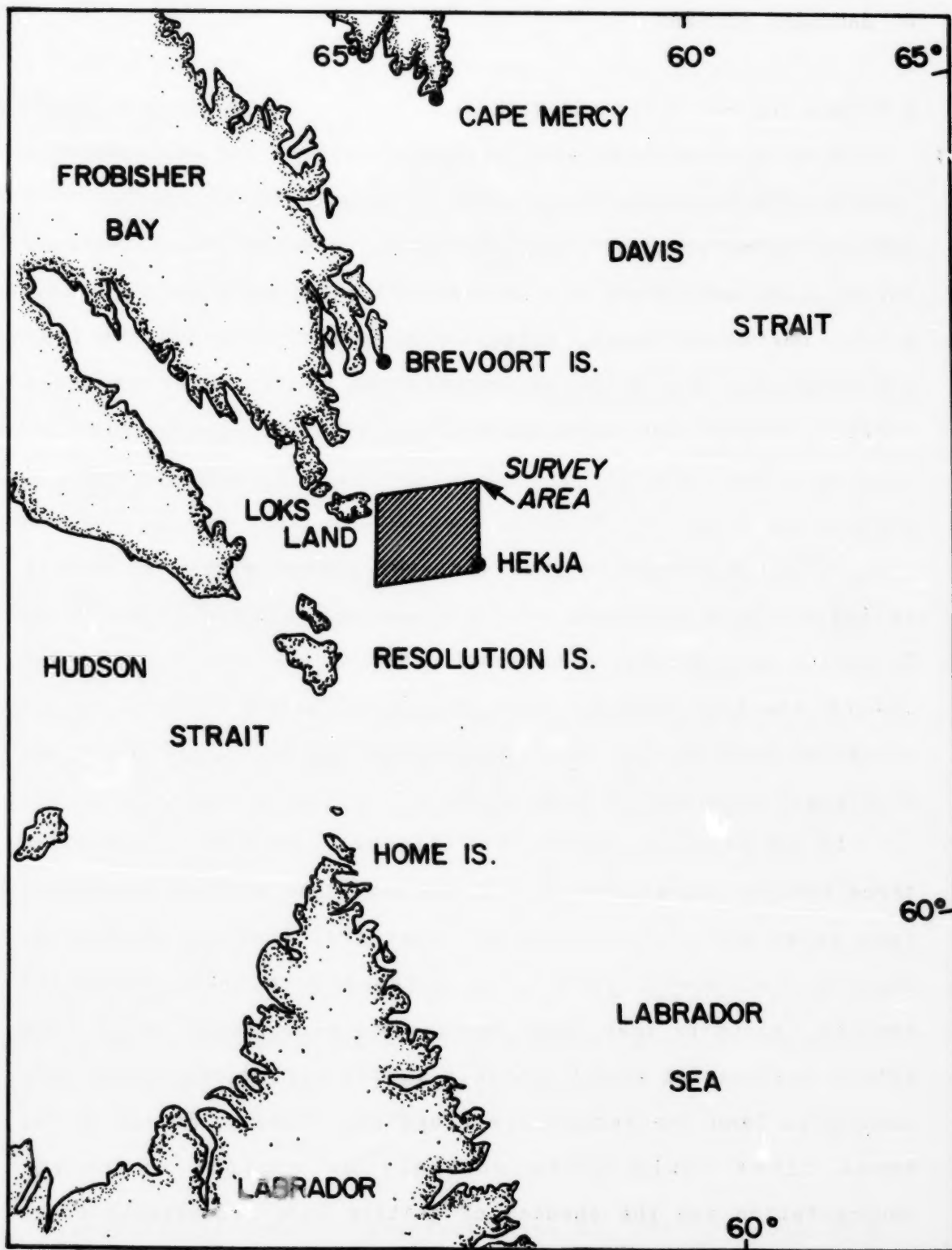


Figure 1. Map of the survey area.

2. SAMPLING PROGRAM

2.1 Sampling Rationale and Methods

A sampling program was designed to effect the best possible results after studying the available bathymetric data (Geonautics 1980a). Other pertinent information and considerations included survey work completed earlier in 1981 by B. Maclean of G.S.C., A.G.C., Dartmouth (pers. comm. C.F.M. Lewis 1981) and the time allocated for the sampling program (48 hours). The designed sampling program was as follows:

2.1.1

The data available indicates the possible existence of a relict beach in the study region at water depths of 85 to 100 m. To verify this assumption two coring/sediment grab stations and a camera station (Station Nos. 39, 40) (Figure 2) were to be attempted here and for similar reasons sample No. 38 was taken at a lower bathymetric level.

In the adjacent deeper area (Figure 2, Station Nos. 41-43), three shallow depressions were construed to be possible submerged lake sites and three coring/sediment grab stations (Figure 2, Station Nos. 41-43) were to be attempted in their proximate centres. Assuming that these depressions were indeed relict lake sites, then coring would probably sample marine and non-marine sediments (and the respective flora and fauna). Furthermore, these sites could quite possibly be regions of recent sedimentation and the chances of getting good recoverable cores

were better than those at the other more exposed areas.

2.1.2

A geophysical transect (line A, Figure 2) between station No. 43 and the Hekja wellsite area were deemed necessary to determine the thickness of sediments along the transect and the frequency of ice scouring with depth. This would also include a partial re-survey of the Hekja wellsite. The location of core, grab and camera stations in the Hekja vicinity were based upon the sidescan mosaic provided by Geonautics Ltd. (Geonautics; 1980 a; b; 1981). The core and grab sample stations were to be carried out in two morphologically contrasting areas within close proximity of the wellhead. The location of the sampling sites were determined from analysis of the mosaic. These sites exhibited:

- (i) the most extensive scouring and
- (ii) the least extensive scouring.

(Sampling station numbers at Hekja are from No. 44 to 48, Figure 2).

2.1.3

Two other sites (Figure 2) were to be sampled from the region. One of the sampling sites is possibly a submerged relict lake (No. 50) and the other a low hill (No. 49).

2.1.4

A geophysical/sidescan transect (line B), was to be run from

Station 50 to the site of Hekja North mosaic (Figure 2). This line and the Hekja North sidescan mosaic were deemed necessary after the data from geophysical line A and the multiparameter line 7 (Figure 3), were cursorily analysed. (The Bedford Institute of Oceanography (BIO) multiparameter lines consisted of reflective seismics, sidescan sonar, HUNTEC Deep Tow System (DTS), magnetometry, gravimetry, and bathymetry).

2.1.5

Geophysical/sidescan transects C and D were designed to determine the sediment thickness along the transects. If deep, 'interesting' and promising deposits of sediments were indicated on the HUNTEC high resolution records, then coring would be initiated at the appropriate sites. (As it turned out, no further coring was carried out).

3. WEATHER CONDITIONS

Weather conditions which effected the sampling of the sediments varied during the three day survey program. Moderately good weather with seas between 1.8 m and 3.0 m associated with wind speeds between 15 and 20 knots prevailed during the sediment sampling program on October 21, 1981. On completion of this sampling program and during the geophysical-sidescan line A (Figures 2 and 3), weather conditions worsened with seas between 2.4 m and 4.6 m; wind speeds were rarely lower than 20 knots. Piston and gravity coring together with sediment sampling were continued on October 22, 1981 in seas of 2.7 m to 4.8 m associated with wind speeds of between 15 and 25 knots. While this made the handling of coring equipment extremely difficult, it is doubtful if it appreciably effected the coring program or the quality of the photographs taken during the camera transects. Thereafter, weather conditions moderated to seas between 1.5 m and 2.4 m, associated with winds of 10 to 15 knots. Geophysical/sidescan lines B, C and D were completed during this period of moderate conditions. The survey was completed on October 23, 1981.

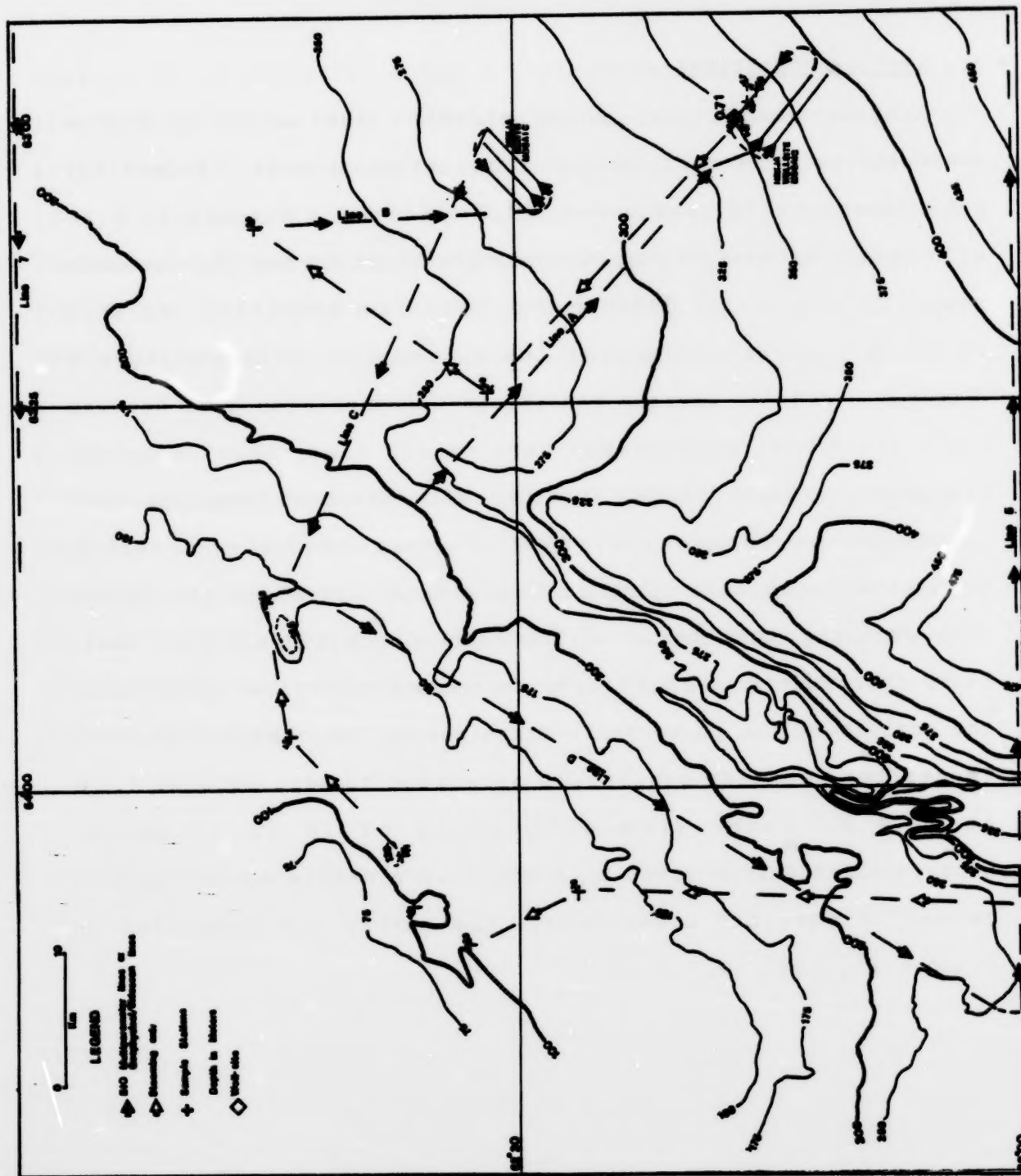


FIGURE 2 Bathymetry of Study Area and Sample Stations

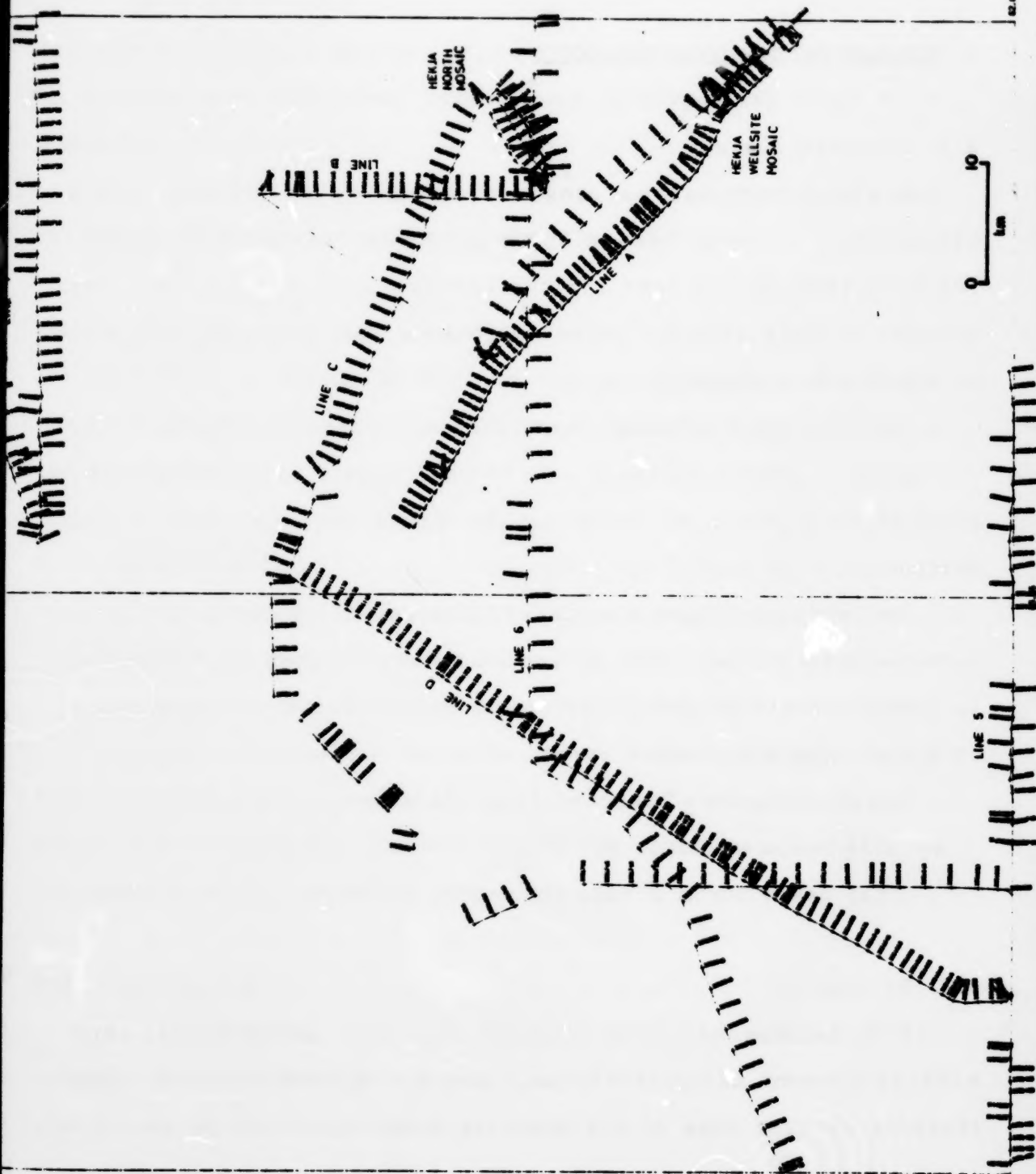


Figure 3 Computer Printout of Ships' Track

4. SUMMARY OF RAW DATA COLLECTED

4.1 Sidescan Survey

A BIO, 70 kz medium range, sidescan sonar system with a variable slant range between 350 m and 750 m (total swath width, 700 m to 1500 m) was used for the survey. Over 209 km (over the ground) of data were collected from both the lines (A, B, C and D) and the two mosaics.

Sidescan data were collected from multiparameter lines 5 and 7 (Figure 2) over a distance of 111 km. Line 6 along 62°20' was discontinued prior to reaching the Hekja vicinity due to bad weather.

The sidescan fish was towed at a depth of about 105 m in water depths of 190 - 260 m, and at a ships' speed of 6.5 knots. In deeper waters of 350 m the sidescan fish was towed at a depth of 260 m, where the speed rarely exceeded 4.5 knots.

Two mosaics were compiled from the side scan records:

(1) Hekja wellsite mosaic

(2) Hekja North mosaic about 18.5 km NW of wellsite 0-71

4.2 Bathymetry

The bathymetry was logged for all geophysical and multiparameter lines surveyed, including the periods when steaming between some of the sampling stations.

4.3 Air-Gun Seismics

The recording of reflective seismic data was made, using a

40 cubic inch airgun source. Within the Hekja vicinity about 104 km of data were collected; these were chiefly along lines A, B, C and D.

One hundred and eleven kilometres of track data were collected from multiparameter lines, 5 and 7.

4.4 HUNTEC Deep Tow System Profiler

The HUNTEC system (planned to determine sediment thickness) operated intermittently. Such data was generated for 209 km of the transects.

4.5 Sample Stations

Grab samples; attempted 15	successful retention: 10
Total Gravity cores; attempted 10	successful retention: 3
Piston cores; attempted 2	successful retention: 2
Camera stations	3 black and white stereo

(See Appendix 4, for detailed description of sample positions, water depth, sediment description, faunal occurrence as well as description of the physical environment).

4.6 Iceberg Log

An iceberg log was maintained for the duration of the survey. Table 1 lists the sitings made during the three days of the survey at the Hekja vicinity.

4.7 Navigation

Positions were fixed at 5 minute intervals using Bionav.

Bionav is an integrated system utilizing Loran C and satellite navigation. The system is generally considered accurate to within 150 m. However, because of a slight malfunction of the Loran C just before and during the occupation of sample stations 39 and 40, it was not possible to determine their exact location.

5. SUMMARY OF FIELD RESULTS

5.1 Bottom Sampling

The seabed was sampled at predetermined sites using a Van Veen grab sampler and a variety of gravity corers. The sampled sites are indicated in figure 2. The amount of sample retained in the grab sampler varied from station to station; the largest sample weighed 1 kg. A perfunctory visual granulometric analysis was made before each sample was bagged. Notes were recorded of the surface features along with any observations on internal structures, stratification or bioturbation; the fauna contained in each grab was also noted. Appendix 4 describes in detail the visual analysis and preliminary interpretation made at each station for the sediment samples recovered.

Stations 38 to 43 consisted largely of medium-to fine-grained sand. Water depths for these stations did not exceed 150 m. None of the sands exhibited any obvious evidence of internal structures. The sediments, which are primarily of Precambrian granitic origin or from reworked Pleistocene deposits (vide Miller et al, 1980) include varying amounts of biogenic carbonate which are probably widely distributed.

The grain size of the biogenic carbonate fraction and the carbonate content by volume and weight both appear to decrease with increasing depth. The coarser grained material occurs in shallower areas and the finer sediments in the deeper areas. It is also possible that in these shallower areas, the coarser sediment may occur as a veneer which overlies fine sand or silt.

This apparent lack of fine sand or silt may be due to the winnowing action of ocean swell, storm waves and currents (either now or in the past). Internal waves in this area of the Davis Strait (Hodgins and Westergard, 1981) also probably shift a substantial amount of sediment, both by saltation and suspension. Mechanical degradation of the carbonate grains is quite advanced indicating that the physical environment in the shallower areas has been and probably still is quite marked; fairly strong tidal currents (vide. Miller et al, 1980, Fig. 18.1 p. 252) in this area are also contributing to this abrasion of carbonate grains.

Small scale primary bedforms were not seen in any of the samples. Strewn throughout the sands are rounded and angular clasts, which were probably ice-rafted into the area. The clasts are of pebble, cobble and gravel sizes and are multi-mineralic and derived presumably from more than one source. Only a few of the surface clasts had a cover of algae indicating deposition of some extended duration.

Sediments from the Hekja wellsite area at about 350 m (Figure 2) were generally medium-to fine-grained sands with a much larger percentage of silt and clay than that observed for the sediments occurring in waters shallower than 150 metres. The clastic sediments are derived from a similar source to those from shoaler waters, however the carbonate content is down (to probably less than 2%). The sample reacted when treated with HCL although no easily identifiable biogenic carbonate grains were seen.

At the sites described above, a quantitative assessment of

hydrodynamic activity is not possible, but shallow and deep currents caused considerable deflection of both the Sidescan and the HUNTEC fishes, so that the angles the tow cables made along the plane to the ship's forward movement were between 20° to 30°. Rounded to angular pebbles and gravel are randomly distributed throughout the area; these have been probably ice-rafted in and have been derived from a variety of source areas. As such, they are not depth dependent.

5.2 Sidescan Survey

During the course of the main CSS Hudson cruise No. HU81-045, 3 BIO multiparametric lines coincidentally ran within the Hekja vicinity along E-W trends at 62°40'N (line 7), 62°20'N (line 6) and 62°00'N (line 5) (see Figure 3). Due to inclement weather conditions, only lines 7 and 5 were completed. Line 7 was completed prior to commencing the Hekja wellsite marine survey.

An interesting observation from the sidescan survey along multiparameter line 7 was the low density of iceberg scours in water depths shallower than 225 m. At approximately this depth there is a 'sharp' increase in the density of scours (some of them possibly fresh); this continues down to about 300 m and thereafter the scour density decreases and the scour features recorded and identified appear to be relict. (This is a tentative conclusion based on the very subdued relief observed as indicated on the sidescan records). Scouring appears to die out

almost completely below 425 m. (This was also near the maximum operating depth for the BIO sidescan fish used in the transect).

Line A, southeast of sample station No. 43, and commencing at a water depth of 196 m to the Hekja wellsite, clearly showed similar sidescan results to that seen along multiparameter line 7. From the start of line A, to about 240 m, the surface of the seabed is more often disturbed by iceberg crater marks than by actual linear iceberg scours. From 240 m to about 305 m, the seabed is extensively scoured with some of the scours 'clean cut' and 'distinct' in their morphology. Such scours may possibly be recent. In deeper waters the density of the scours decreases gradually and the scour relief is much more subdued, perhaps indicating an older age population. Some of the scours exceed 500 m in length.

The sidescan survey at the Hekja wellsite resurveyed and enlarged upon some of the ground covered in the previous mosaic completed by Geonautics Ltd. in 1981. Features that could be the 1980 wellhead were seen on the sidescan record but a further analysis of the data will be required to confirm this. The Hekja North mosaic (Figure 2), at a depth between 275 m and 300 m revealed a seabed which is thoroughly scoured. Some of the scours have a sharp definition suggesting scouring is a modern process or that scour degradation is slow. If iceberg scouring is a modern phenomenon in the area, then the scour distribution suggests that some of the icebergs coming down this coastline, have draughts in excess of 250 m. The maximum depth at which a 'fresh' looking scour was observed was at about 280 m. Assuming

that small icebergs do occur in this area, then perhaps the prevailing currents and winds prevent them from grounding in the shallower depths. (The sidescan records indicate little scouring in the shallower waters of approximately 150 to 200 m in depth). Nevertheless, it is interesting to note that most of the icebergs recorded in the iceberg log (Table 1) were recorded from areas northwest of the survey area where the water depth was much shallower.

Although air-gun seismics were undertaken during the survey, these were not examined in context to the sampling program undertaken.

Conclusion

In conclusion this account is intended to serve as both a cruise report and a data report for the C-CORE program in the Hekja wellsite area. For this reason it attempts to be complete in reporting the materials and data completed rather than attempting any significant analysis of the data. A detailed report of the analysis of the data collected will follow this report at a later date.

TABLE 1

0001	DAY	TIME	SITE	SHIP LAT	SHIP LON	RANGE	BEARING	ICE LAT	ICE LON
0002	293	2214	414	62° 29.2'	63° 44.60'	6.00	303.0	62° 32.47'	63° 55.51'
0003	293	2214	415	62° 29.20'	63° 44.60'	9.30	322.0	62° 36.53'	63° 57.65'
0004	293	2214	416	62° 29.20'	63° 44.60'	12.30	330.0	62° 39.85'	63° 57.99'
0005	293	2214	417	62° 29.20'	63° 44.60'	7.20	352.0	62° 36.33'	63° 46.70'
0006	293	2214	418	62° 29.20'	63° 44.60'	9.70	30.0	62° 37.60'	63° 34.05'
0007	293	2214	419	62° 29.20'	63° 44.60'	11.70	33.0	62° 39.01'	63° 30.73'
0008	293	2214	420	62° 29.20'	63° 44.60'	13.60	221.0	62° 18.94'	64° 3.80'
0009	293	2214	421	62° 21.98'	63° 28.32'	17.10	258.0	62° 18.42'	64° 4.31'
0010	294	40	422	62° 21.98'	63° 28.32'	15.40	305.0	62° 30.81'	63° 55.65'
0011	294	40	423	62° 21.98'	63° 28.32'	15.70	327.0	62° 35.15'	63° 46.89'
0012	294	40	424	62° 21.98'	63° 28.32'	25.80	332.0	62° 44.76'	63° 54.77'
0013	294	40	425	62° 21.98'	63° 28.32'	21.20	340.0	62° 41.90'	63° 44.13'
0014	294	40	426	62° 21.98'	63° 28.32'	14.60	349.0	62° 36.31'	63° 34.37'
0015	294	40	427	62° 21.88'	63° 28.10'	15.80	355.0	62° 37.62'	63° 31.10'
0016	294	43	428	62° 27.50'	63° 32.09'	11.30	292.0	62° 31.73'	63° 54.80'
0017	295	1020	429	62° 27.50'	63° 32.09'	13.50	308.0	62° 35.81'	63° 55.20'
0018	295	1020	430	62° 27.50'	63° 32.09'	16.10	317.0	62° 39.27'	63° 55.99'
0019	295	1020	431	62° 27.50'	63° 32.09'	10.00	322.0	62° 35.38'	63° 45.46'
0020	295	1020	432	62° 27.50'	63° 32.09'	16.50	328.0	62° 41.49'	63° 51.15'
0021	295	1020	433	62° 27.50'	63° 32.09'	18.10	330.0	62° 43.17'	63° 51.83'
0022	295	1020	434	62° 27.50'	63° 32.09'	14.90	332.0	62° 40.66'	63° 47.33'
0023	295	1020	435	62° 27.50'	63° 32.09'	14.90	346.0	62° 41.96'	63° 39.95'
0024	295	1020	436	62° 27.50'	63° 32.09'	8.60	0.0	62° 36.10'	63° 32.09'
0025	295	1020	437	62° 27.50'	63° 32.09'	10.00	10.0	62° 37.35'	63° 28.31'
0026	295	1020	438	62° 27.67'	63° 32.88'	17.40	238.0	62° 18.45'	64° 4.63'
0027	295	1023	439	62° 23.92'	63° 51.72'	8.30	349.0	62° 32.07'	63° 55.15'
0028	295	1218	440	62° 23.92'	63° 51.72'	12.20	352.0	62° 36.00'	63° 55.41'
0029	295	1218	441	62° 23.92'	63° 51.72'	15.80	353.0	62° 39.60'	63° 55.91'
0030	295	1218	442	62° 23.92'	63° 51.72'	18.20	2.0	62° 42.11'	63° 50.34'
0031	295	1218							

Iceberg Log for the Hekja vicinity.

0032	295	1218	443	62° 23.92'	63° 51.72'	12.30	13.0	62° 35.90'	63° 45.71'
0033	295	1218	444	62° 23.92'	63° 51.72'	19.30	16.0	62° 42.47'	63° 40.12'
0034	295	1218	445	62° 23.92'	63° 51.72'	15.80	34.0	62° 37.02'	64° 32.51'
0035	295	1218	446	62° 23.92'	63° 51.72'	17.70	36.0	62° 38.24'	63° 29.08'
0036	295	1218	447	62° 23.92'	63° 51.72'	7.50	230.0	62° 19.10'	64° 4.09'
0037	295	1348	448	62° 15.90'	64° 3.64'	16.70	13.0	62° 32.17'	63° 55.49'
0038	295	1348	449	62° 15.90'	64° 3.64'	3.11	348.0	62° 18.94'	64° 5.03'
0039	295	1348	450	62° 15.90'	64° 3.64'	9.50	320.0	62° 23.18'	64° 16.81'
0040	295	1348	451	62° 15.90'	64° 3.64'	9.30	310.0	62° 21.88'	64° 19.00'
0041	295	1348	452	62° 15.90'	64° 3.64'	9.70	302.0	62° 21.04'	64° 21.37'
0042	295	1348	453	62° 15.90'	64° 3.64'	11.10	292.0	62° 20.06'	64° 25.81'
0043	295	1348	454	62° 15.90'	64° 3.64'	11.40	336.0	62° 26.31'	64° 13.66'
0044	295	1348	455	62° 15.90'	64° 3.64'	11.20	329.0	62° 25.50'	64° 16.10'
0045	295	1348	456	62° 15.90'	64° 3.64'	11.20	327.0	62° 25.29'	64° 16.82'
0046	297	1515	457	61° 40.00'	63° 55.00'	14.20	282.0	61° 42.95'	64° 24.31'
0047	297	1515	458	61° 40.00'	63° 55.00'	15.00	277.0	61° 41.38'	64° 26.40'
0048	297	1515	459	61° 40.00'	63° 55.00'	12.30	225.0	61° 31.30'	64° 13.24'
0049	297	1710	460	61° 37.60'	64° 16.34'	6.70	325.0	61° 42.08'	64° 26.85'
0050	297	1710	461	61° 37.60'	64° 16.34'	6.49	311.0	61° 41.86'	64° 26.67'
0051	297	1710	462	61° 37.60'	64° 16.34'	7.13	271.0	61° 37.72'	64° 31.34'
0052	297	1710	463	61° 37.60'	64° 16.34'	4.95	229.0	61° 34.35'	64° 24.19'
0053	297	1710	464	61° 37.60'	64° 16.34'	9.23	232.0	61° 31.92'	64° 31.60'
0054	297	1710	465	61° 37.60'	64° 16.34'	6.95	166.0	61° 39.75'	64° 2.42'
0055	297	1949	466	61° 20.06'	64° 28.49'	12.10	350.0	61° 31.98'	64° 32.90'
0056	297	1949	467	61° 20.06'	64° 28.49'	11.10	1.0	61° 31.16'	64° 28.08'
0057	297	1949	468	61° 20.06'	64° 28.49'	9.96	33.0	61° 28.41'	64° 17.13'

Iceberg Log for the Hekja vicinity.

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APPENDICES

APPENDIX A

Scientific personnel responsible for the Hekja marine survey:

C.M.T. Woodworth-Lynas - C-CORE

C.P.G. Pereira - C-CORE

C.F.M. Lewis - AGC/BIO

APPENDIX B

Brief description of Gravity corers used:

(i) Leheigh corer:

A Leheigh gravity corer consists of a grey PVC core barrel, generally 2 to 3 m in length, with an internal diameter of about 10 cm (Figure B 1). At the bottom of the core barrel is a metallic spring catcher, which effectively retains the core in the core barrel by closing shut around the core when the core barrel is pulled free from the seabed. The top of the core barrel clamps into a socket, just below the lead driving weights; it is then secured by screwing a clamp. The weight of the lead driving weights on the corer can be varied depending upon the requirements of the coring program and the type of sediment on the seabed.

(ii) Benthos corer (also used as the Trigger corer in conjunction with a piston corer):

A Benthos gravity corer consists of an inner transparent PVC core barrel from 2 to 3 m in length with an internal diameter of about 7.5 cms which is slotted into a cylindrical steel barrel (Figure B 1). The steel barrel itself is screwed into a socket immediately below the lead driving weights. The PVC core barrel is prevented from falling out of the steel barrel by a brass cutting head which screws into the steel barrel. As in the Leheigh corer a metallic spring core catcher is attached to the PVC core barrel.

(iii) Piston Corer:

The Piston corer is similar in construction to the Benthos corer, except that it has a split piston inside the core barrel and the core barrel can be 14 m or more in length (Figure B 2). The 2000 kg piston corer is generally used in conjunction with a Benthos trigger corer. The trigger corer hangs from a boom clamped to the steel cable which holds the piston corer. The trigger corer has a lead of about 14 m, below the barrel of the piston corer. When the trigger corer impacts on the bottom, it releases a trigger mechanism on the piston corer, which then free falls the measured distance so that there is sufficient momentum to drive the core into the sediment, yet not enough to cause any appreciable yawing.

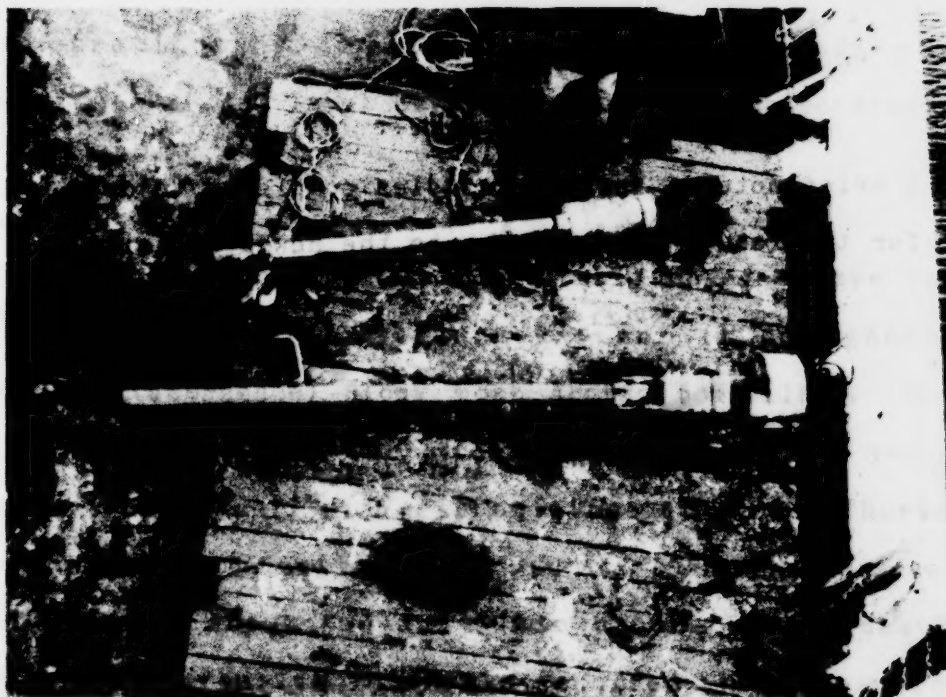


Figure B1 & B2. Benthos Corer (Right)
Lehigh Corer (Left)



Figure B3. Piston Corer and
Trigger (Benthos) Corer.

APPENDIX C

SEA LEVEL FLUCTUATIONS FOR THE BAFFIN ISLAND AREA

A brief note of sealevel studies completed to date for the land area, adjacent to the Hekja wellsite.

INTRODUCTION

A simple but useful rheological model of the earth consists of an elastic lithosphere overlying a viscous fluid interior. With a lithosphere 100 km thick, considerable elastic bending takes place in the vicinity of the ice margin and the strength of the lithosphere serves to distribute the effect of the ice load well beyond the ice margin. The interaction between the global process of sea level changes due to ice and ocean volume changes, and the regional processes of glacio-isostatic and tectonic movements produces sedimentary sequences composed of on-lapping and off-lapping marine facies. Hence due to this variable response of surface geomorphic and sedimentary structures to these processes, no single sea-level model can be applied to the entire coast of the Arctic nor can a single model be applied over distances of 1000 km or so without an adequate check of the field stratigraphy. Thus site specific studies are a prerequisite, if sea level curves for any designated area are to have any intrinsic value.

SEA LEVEL CYCLES

Glacio-isostatic and glacio-eustatic changes have resulted in a series of marine transgressions (submergence) and regressions (emergence) along most Arctic coastlines. However, the nature and timing of these periods of high and low sea levels (relative to present) differ from place to place. During the upper Quaternary the maximum amplitude of the transgressive stage varies between about 400 and 500 m above present sea level, whereas the regressive intervals resulted in assumed low sea

level stands between 100 and 200 m, below present. Superimposed on these relative movements of sea level, caused by glacial isostasy or eustasy are longer term tectonic crustal movements. However in terms of the late glacial and post glacial events these latter crustal movements can be ignored.

The maximum elevations of the marine transgressions are recorded and represented by glacio-marine deltas that were deposited at the glacier margins. The extent of the marine regression at any point would be determined by the interaction between the local/regional glacial load and world sea level, with secondary effects due to global and regional responses to isostatic and gravitational balance - any analysis must be treated with caution. Visible evidence for the 'sea level stratigraphy' is of two kinds; morphological evidence for former sea levels, e.g. wave cut platforms glacio-marine debris, etc., and from changes in fossil assemblages and litho facies. More accurate correlation between sediments relies on radiocarbon dates, amino acid racemisation, etc.

EAST BAFFIN ISLAND AREA - SEA LEVEL MOVEMENT

Emerged and submerged sediments and geomorphic forms along the eastern coast of Baffin Island record a series of marine transgressions and regressions that span the last interglacial/glacial/Holocene cycle. (See Figure C 1 for areas of study). Seven episodes in the relative sea level history of eastern Baffin Island over the last glacial/interglacial cycle (ca. 125,000 years) can be postulated from evidence on the shoreline and from stratigraphic sections, but only the first three

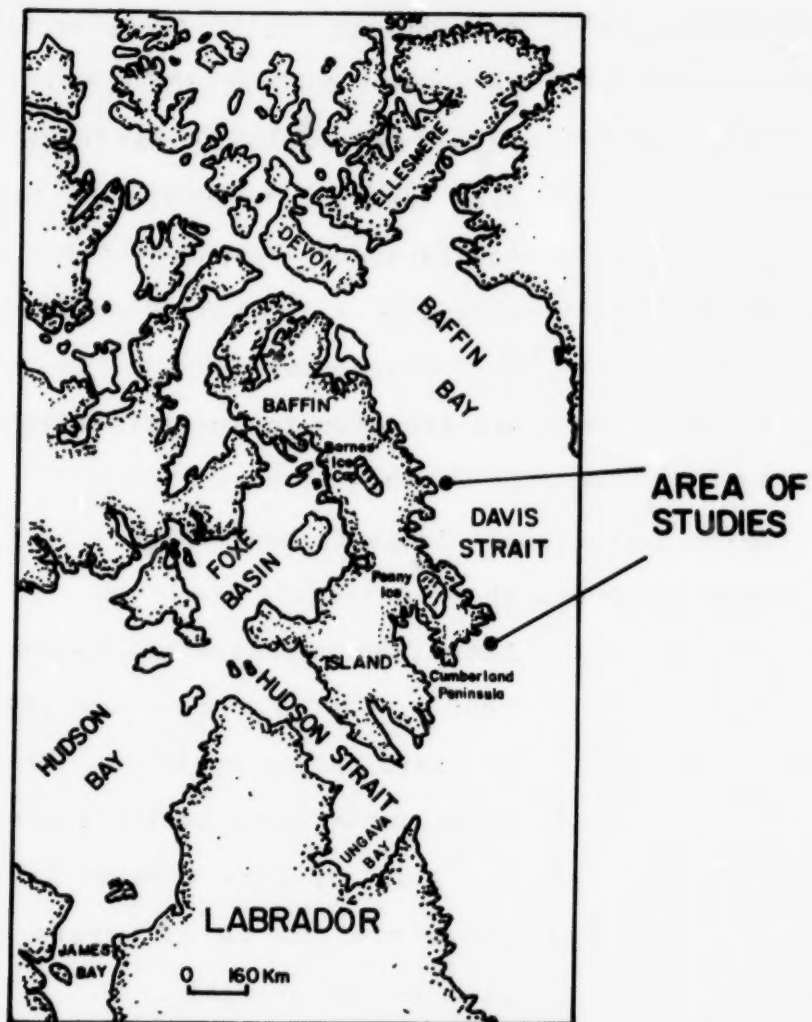


Figure C1. Map of area of seal level studies

episodes are of interest here.

A. Marine Transgression: Canso Channel Transgression

Last 1,000 years.

Canso Channel is on the Cumberland Peninsula (Figure 1). Transgression has been determined from buried soil. Dates of the soil cluster between 1,000 and 800 B.P. (Before Present). Relative sea level has risen by about 1 m. over the last 1,000 years. Possible causes:

- (a) Isostatic response of ice caps growth
- (b) effects related to larger isostatic movements
- (c) increase in the effective level of storm tides.

B. Marine Regression: Inugsuin Regression

-1000 to 8000 + BP

Shoreline building has taken place at about 7800 +, 6400 +, 4800+ and 2800 + BP - dated by radio carbon analysis. Sea level oscillations during this period occurred between + 2 to 19 m. Different dates given immediately above are due to different specific sites used in the analysis.

C. Marine Transgression: Cape Adair Transgression

-8000 to 18,000 + B.P.

Marine transgression culminated about 8000 B.P. (Stratigraphic evidence from in-situ

soils) - this transgression is not primarily associated with a significant increase in rate of world sea level rise rather as a marine transgression against the isostatically depressed coast of Baffin Island at a time when the Laurentide Ice sheet held steady or even readvanced. Low stands of sea level were determined by echo soundings; large glacio-marine deltas 20 to 40 m below sea level (tidal range 1.5 m).

(Broughton Island Pigjoat foreland area). Cape Adair transgression in the above mentioned foreland area extended to about 5 to 7 m above sea level and maximum 9850 $\pm$ 250 B.P. Consistent submerged features related to the above transgression were noted at -18, 67 to 73 and 94 to 102 m below sea level.

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APPENDIX D
SAMPLE POSITIONS AND DESCRIPTIONS

Sample No. 1

Hudson Station No. 38 137 meters of water October 20, 1981

62°18.5'N 64°10.8'W

Sampling method used: 1 Leheigh gravity core: No retention

1 Van veen grab: successful

Munsell colour code: 10YR 4/1

Remarks: The sample is grey-brown with white speckles. The sediment is predominantly a medium to coarse grained sand (0.25 mm to 1.5 mm) with lesser amounts of fine sand (less than 0.25 mm) - the sediment is loosely compacted. Overlying this loosely compacted sand are some randomly distributed pebbles and gravel (- doubtful if it forms a veneer or pavement on the surface). The clastic quartz and the other grey and black sediments have been probably derived from a granitic source rock. The white grains of sediment which make a marked contribution (ca. 10-15% by volume) to the overall sediment are shell fragments, most of which are plate-like in structure. Coral fragments are also found associated with the gravel. The medium-to coarse-grained clastic particles are angular to sub-rounded and sub-spherical in shape. Tentative visual and cursory analysis of the sediments suggests that the environment is affected by moderate to strong

currents which winnow away the sediment fines, or in these shallow waters, severe storms could resuspend fine sediments which would then be removed by the prevailing currents. The penetration into the sediment by the grab used was probably between 5-14 cm. Live fauna collected at this station were starfish, brittle stars and bryozoans.

The Leheigh corer deployed at this station returned with the bottom 15 cm of the corer tip broken off, probably as a result of striking a boulder. No further coring attempts were made since even if penetration was successful, the catcher in the corer was not small enough to retain the sand.

Sample No. 2

Hudson Station No.39 115 metres of water October 20, 1981

62°22.8'N 64°14.8'W

Sampling method used: 1 Van veen grab: successful

Core not attempted

Munsell colour code: 10YR 4/1

Remarks: Colour of sample is a speckled grey-brown, but the speckled effect is slightly more pronounced than the previous sample (Station 38). The sediment is predominantly a medium to coarse sand (0.25 mm to 1.5 mm). Fine sand and silt probably constitute between 10-15% of the sample. Gravel and pebbles are not common in this sample. Source rock for the clastic quartz and related sediments is probably granitic. The white carbonate plate-like fragments which constitute between 10-20% by volume of the sample are the end-products of the predominantly mechanical degradation of in situ and transported modern shells. The medium to coarse grain sand particles are angular to sub-rounded. Tentative visual and cursory analysis of the sediments suggests that the physical environment is probably affected by moderate to strong currents which winnow away sediment fines. Both coarse and fine sediments sent into resuspension by storm waves will be redistributed by the prevailing shallow water currents. The penetration into the surface sediment by the grab used was probably between 5-15cm. Live fauna collected at this station were sea urchins, shrimps and other small biota.

Sample No. 3

Hudson Station No. 40 82 metres of water October 20, 1981
62°24.6'N 64°09.92'W

Sampling method used: 1 Van veen grab: Successful

No core attempted

Camera Station: Stereo black & white
photographs

Munsell colour code: 10YR 4/1

Remarks: Colour of sample is greyish-brown with white grained specks. The sediment is predominantly medium-to coarse-grained sand within the granulometric size range 0.25 mm to 1.5 mm. Fine sand and silt probably constitute less than 10% of the sample. Sediment on the whole is loosely compacted. Gravel and pebbles are scarce and would appear to be randomly distributed. Source rock for the clastic quartz and related sediments is probably granitic. Shell fragments in this sample are much coarser and range up to 20 mm in size; this biogenic carbonate content probably forms between 10-20% by volume of the sample. The clastic sediment grains are angular to subrounded. This sample site is the most vulnerable to storm waves (and probably well within the wave-base range of large Atlantic swells) and current action of the sites sampled so far - this is reflected by the greater abundance of large biogenic fragments, i.e., the finer sediment being winnowed away. The penetration into the sediment by the grab was probably between 5-14cm. Live fauna

recovery was the least amongst the samples collected so far and none were identified in the field.

Approximately 23 black and white stereographic photographs were taken of the seabed along a transect of about 300 m, from a height of about 4 m.

Sample No. 4

Hudson Station No. 41 133 metres of water October 20, 1981

62°24.62'N 64°06.20'W

Sampling method used: 2 Van veen grabs: unsuccessful

Core not attempted

Munsell colour code: -----

Remarks: The site picked for this sample was a depression east of Station 40. The sampling appeared to have taken place on a cobble bed possibly at the rim of the depression, this perhaps explaining the reason for both van veen attempts resulting in the jaws of the grab being jammed open by a pebble each time. (If there was any underlying sand caught by the grab, it would have all escaped!) The pebble in each instance was well rounded and about 4.5 cm in diameter.

Sample No. 5

Hudson Station No. 42 133 metres of water October 20, 1981
62°29.3'N 63°55.7'W

Sampling method used: 1 Leheigh gravity core: no retention
1 Van veen grab: Successful

Munsell colour code: 10YR 4/1

Remarks: The sample is a speckled grey-brown colour, but there is a marked decrease in the white speckled grains. The sediment is predominantly a medium to fine grained sand within the size range of 0.25 mm to 1.0 mm; finer sand and silt make a marked contribution to the sample (ca. 20% by volume); the sediment is moderately compacted. Overlying this sediment layer are randomly distributed gravels and pebbles. As in the previous samples most of the sediment is derived from a granitic source rock. The white grains in the sediment are biogenic carbonates, derived from sea shells; the carbonate contribution to the sediment is about 5-10% by volume. The physical environment is probably quite turbulent, however the decrease in biogenic carbonates may reflect a more turbulent physical environment or simply a lack of live shell-forming fauna in the vicinity. The penetration into the sediment by the grab used was probably between 7.5-15cm.

The Leheigh corer deployed at this station returned with the top 15 cm of the corer tip broken off. The site of this sample was also a depression (similar to that of 41) where moderate sediment deposits were anticipated.

Sample No. 6

Hudson Station No. 43 155 metres of water October 20, 1981
62°30.6'N 63°43.6'W

Sampling method used: 2 Van veen grabs: 2nd attempt successful
Munsell colour code: 10YR 4/1.5

Remarks: The white specks have all but disappeared from the sediment, leaving the sample with a uniform dirty grey colour. The sediment is almost uniformly a fine sand (0.25 mm to 0.50 mm in size) grading into silt and possibly clay. Scattered cobbles and pebbles overly the sediments - the cobbles and pebbles examined were derived from more than one source area and were probably ice rafted in. The biogenic carbonate content in the form of the white speckles is probably down to less than 3% by volume.

Sample No. 7

Hudson Station No. 44 365 metres of water October 21, 1981

62°11.15'N 63°00.70'W.

Sampling method used: 1 Van veen grab: successful

2 Leheigh gravity cores: No retention

1 Benthos gravity core (Trigger core):

Small collection of pebbles
retained

1 Piston core: Apparent penetration

2.8 metres length of core
retained 90cm

Munsell colour code: 10YR 5/1 for grab sample

Remarks: The sample is a uniform light grey colour. The sediment is predominantly a medium grained sand with very little fine sand or silt. A few large angular cobbles of various origins were brought up with the sample. Biogenic carbonate material is almost completely absent from the sample.

The first Leheigh gravity core failed to retrieve anything; the second attempt might have penetrated up to 90cms but the barrel broke when it was being extracted (from the cored site!). The Benthos corer retrieved about 30cms of sediment. The piston core had an apparent penetration of 2.8 metres, but only a 90 cm core was retained in the core barrel. Visual observation of the core through the perspex core barrel indicated a fining of sediments down the barrel with the bottom (at the 90cm marker)

being a greyish silty clay with a plastic consistency.

Sample No. 8(a)

Hudson Station 45A 350 metres of water October 21, 1981
62°10.9'N 62°58.03'W

Sampling method used: 1 Benthos gravity core (Trigger core):
little retention

1 Piston core: Retention 37 cm

Munsell colour code: -----

Remarks: The core barrel had an apparent penetration depth of approximately 1.84 metres from which a core of only 37cm was retrieved. Initial observation of the retained core examined through the transparent perspex core barrel indicated a light grey-coloured coarse sandy sediment on the top rapidly becoming finer down the core tube. A similar sized core but only about 20cm long was retrieved by the Benthos gravity corer (i.e. the Trigger Corer).

Sample No. 8(b)

Hudson Station 45B 350 metres of water October 21, 1981
62°10.8'N 62°58.03'W

Sampling method used: 1 Leheigh gravity core: No retention
Munsell colour code: -----

Remarks: Barrel shattered in half either on impact or if penetration was achieved, it broke when the winch started to extract it from the seabed.

Sample No. 9

Hudson Station 46

387 metres of water

October 21, 1981

62°10.25'N

62°56.94'W

Sampling method used: 1 Leheigh gravity core: No retention

Munsell colour code: -----

Remarks: Apparent penetration into the seabed was about 30cms but no core retained in the core barrel - possible that it fell out when core barrel hit the side of ship, just before being pulled in.

Sample No. 10(a)

Hudson Station 47A

365 metres of water

October 21, 1981

62°10.25'N

62°57.25W

Sample method used: Camera Station: Stereo black & white photographs

Remarks: Approximately 25 black and white stereographic photographs were taken of the seabed along a transect of about 300 metres from a height of about 4 metres.

Sample No. 10(b)

Hudson Station 47B 397 metres of water October 21, 1981
62°09.8'N 62°02.4'W

Sampling method used: 2 Van veen grabs: only 1 successful

Munsell colour code: 10YR 4/3

Remarks: The sample is a dark grey colour. The sediment is predominantly a medium-to fine-grained sand (within the possible size range of 0.12 mm to 0.75 mm) with smaller amount of silt and possibly clay; it is also moderately compacted. Overlying this sediment is a layer of randomly distributed gravel. The carbonate shell content in the sediment is probably less than 2%; the clastic sediment probably has its origin from a granitic source rock - most of the sediment grains are angular to subangular. The penetration into the sediment by the grab was probably less than 7cm. No live fauna were recovered at the station.

Sample No. 11

Hudson Strait No. 48 347 metres of water October 21, 1981
62°11.06'N 63°00.69'W

Sampling method used: Camera Station: Stereo black & white
photographs

Remarks: Approximately 25 black and white stereographic photographs were taken of the seabed along a transect which commenced at the above coordinates and was completed at 62°11.237N and 63°00.415W. The height of the camera above the seafloor was about 4 metres.

Sample No. 12

Hudson Station No.49 256 metres of water October 22, 1981

62°21.88'N 63°21.90'W

Sampling method used: 2 Van veen grabs: One successful

Munsell colour code: 10YR 4/3

Remarks: The colour of the sample is dark-grey. The sediment is predominantly a medium to fine grained sand (within the possible size range of 0.12 to 0.75 mm), with smaller amounts of silt and possibly clay; the sediment is moderately well compacted. Overlying this sediment is a layer of coarse gravel clasts of which are angular to subrounded. The composition of the gravel indicates that its origin is from more than one source, i.e. ice rafting contributed to its placement into this area. The penetration into the sediment by the grab was probably less than 5cm. Gastropods were the only live fauna recovered at this station.

Sample No. 13

Hudson Strait No. 50 265 metres of water October 22, 1981
62°30.2'N 63°09.5'W

Sampling method used:

1 benthos gravity core: 15cms retention

1 Leheigh gravity core: No retention

1 Van veen grab: successful

Munsell colour code: 10YR 4/3

Remarks: The sediment is dark grey in colour and is predominantly a medium-to fine-grained sand with lesser amounts of silt and possibly clay. Overlying this sediment is a randomly distributed layer of gravel and pebbles. The carbonate content in the sediment is probably very low and could be less than 2%; the clastic sand grains are angular to subrounded and are derived from a granitic source rock. The penetration into the sediment by the grab was probably less than 5cm. No live fauna were retrieved.

